Atlantic Halibut All-Sizes Tagging Program Summary Report for 2006 to 2011

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by

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ABSTRACT

den Heyer, C.E, Armsworthy, A., Wilson, S., Wilson, G., Bajona, L., Bond, S., and Trzcinski, M.K. 2012. Atlantic Halibut All-Sizes Tagging Program Summary Report for 2006 to 2011. Can. Tech. Rep. Fish. Aquat. Sci. 2992: vi+38 p.

In 2006, Fisheries and Oceans Canada (DFO) and the Atlantic Halibut Council (AHC) began the Halibut All Sizes Tagging (HAST) program to estimate exploitation rate, describe the movement and distribution of halibut within the Scotian Shelf-southern Grand Banks management unit (NAFO Divs. 3NOPs4VWX5Zc), and estimate population size. Between 2006 and 2010, 2771 Atlantic Halibut caught during the DFO-Industry Halibut Survey were double tagged with t-bar anchor tags and released. Fishermen were compensated for the release of tagged halibut of commercial value (≥81 cm). Tag release information was recorded by fisheries observers and entered into DFO's Industry Surveys Database (ISDB). Fishermen were asked to return tags to DFO with information on the size, sex, date and location of recapture of tagged halibut. Each reported halibut was rewarded with $100 and an entry into a quarterly lottery for $1000. The tag recapture data is entered directly into the Halibut Tagging Database, an event-based Oracle database developed to house the release data extracted from the ISDB and the reports of recapture. Here we document the tagging program and database and identify areas for improvement.

Consistent with high tag retention and the low mortality of halibut, fish tagged in 2006 are still being recaptured. Fishing and natural mortality between 2006 and 2010 were estimated using a multiyear mark-recapture model that incorporates estimates of tag loss and allows for incomplete mixing in the first year of release. Assuming 90% tag reporting and 80% survival from tagging, average instantaneous natural mortality (*M*) for halibut was estimated to be 0.16 (SE=0.07), and instantaneous fishing mortality (*F*) was estimated to be 0.15 (SE=0.03) in 2007, 0.22 (SE=0.03) in 2008, 0.15 (SE=0.03) in 2009, and 0.13 (SE=0.03) in 2010. Despite increases in the Total Allowable Catch (TAC), *F* declined in 2009 and 2010, which is consistent with a recruitment pulse. When length at time of recapture was reported, we were able to estimate annual growth. After removing reports that estimated negative or unreasonably high annual growth, there was no difference in annual growth between males and females, but the annual growth for halibut less than a 100 cm at the time of release (mean=9.4 cm•year^{-1}, n=129) was slower (t=3.27, p<0.01) than those greater than or equal to100 cm (mean=6.6 cm•year^{-1}, n=107). The net movement between release and recapture ranges from 0 to 3140 km, with a median of 27 km. Although movements were concentrated along the east-west axis, there was no significant bias in the direction of movement (Rayleigh test, p=0.10, n=441). We found no difference in the mean distance moved between release and recapture between small (<81 cm) and large (≥81 cm) halibut, as would be expected if there was juvenile dispersal. All of the reports of recapture with location information (latitude and longitude, or NAFO area, n=466) were within the management unit, with the exception of seven reports in the Gulf of St. Lawrence, three reports from the Gulf of Maine, two reports from Iceland and one from near Baffin Island. The retention of halibut in the management unit provides support for the current definition of the stock.

RÉSUMÉ

den Heyer, C.E, Armsworthy, A., Wilson, S., Wilson, G., Bajona, L., Bond, S., and Trzcinski, M.K. 2012. Rapport sommaire du programme de marquage du flétan de l'Atlantique (toutes tailles) pour la période de 2006 à 2011. Can. Tech. Rep. Fish. Aquat. Sci. 2992: vi+38 p.

En 2006, Pêches et Océans Canada (MPO) et l'Atlantic Halibut Council (AHC) ont lancé un programme de marquage visant les flétans de l'Atlantique de toutes tailles, pour estimer le taux d'exploitation de l'espèce, décrire ses déplacements et sa répartition dans l'unité de gestion du plateau néo-écossais et du sud des Grands Bancs (division de l'OPANO 3NOPs4VWX5Zc) et estimer la taille de la population. Entre 2006 et 2010, 2 771 flétans de l'Atlantique ont été capturés et marqués au moyen de deux étiquettes en T dans le cadre des relevés effectués par l'industrie et Pêches et Océans Canada, avant d'être libérés. Les pêcheurs étaient indemnisés pour les flétans marqués libérés de taille commerciale (≥81 cm). L'information sur les lieux de remise à l'eau est inscrite par des observateurs des pêches et saisie dans la base de données des relevés de l'industrie. Il a été demandé aux pêcheurs de renvoyer à Pêches et Océans Canada les étiquettes, avec des renseignements sur la taille, le sexe, la date et le lieu de recapture du flétan marqué. Chaque flétan signalé donnait droit à 100 $ et à un billet de participation à une loterie trimestrielle avec un lot de 1 000 $. Les données de recapture de l'étiquette sont directement saisies dans la base de données du marquage du flétan, une base de données Oracle basée sur les événements, développée pour héberger les données de remise à l'eau extraites de la base de données des relevés de l'industrie et des rapports de recapture. Ceci permet de documenter le programme et la base de données de marquage et de déterminer les améliorations nécessaires.

En raison d'un maintien élevé des étiquettes et de la faible mortalité du flétan, les poissons marqués en 2006 continuent d'être recapturés. La mortalité naturelle et causée par la pêche entre 2006 et 2010 a été estimée au moyen d'un modèle pluriannuel de marquage-recapture qui tient compte des estimations de pertes d'étiquettes et permet de considérer un mélange incomplet avec les individus récemment marqués pendant la première année de remise à l'eau. En supposant que 90 % des étiquettes font l'objet d'un rapport et que 80 % des individus survivent au marquage, la mortalité naturelle instantanée du flétan (*M*) est estimée à 0,16 (ET=0,07) et la mortalité instantanée par pêche (*F*) à 0,15 (ET=0,03) en 2007, 0,22 (ET=0,03) en 2008, 0,15 (ET=0,03) en 2009 et 0,13 (ET=0,03) en 2010. Malgré une augmentation du total autorisé des captures (TAC), *F* a diminué en 2009 et 2010, ce qui indique un pic de recrutement. Le signalement de la longueur au moment de la recapture a permis d'estimer la croissance annuelle. Après avoir supprimé les rapports estimant une croissance annuelle négative ou déraisonnablement élevée, aucune différence n'a été constatée entre la croissance annuelle des mâles et des femelles, mais la croissance annuelle des flétans mesurant moins de 100 cm au moment de la remise à l'eau (moyenne = 9,4 cm•an^{-1}, n=129) était plus lente (é=3,27, p<0,01) que celle des individus de taille supérieure ou égale à 100 cm (moyenne = 6,6 cm•an^{-1}, n=107). Le déplacement net entre la remise à l'eau et la recapture varie de 0 à 3 140 km, avec une médiane de 27 km. Bien que les déplacements se fassent essentiellement sur un axe est-ouest, aucun biais significatif n'a été constaté dans la direction du déplacement (test de Rayleigh, p=0,10, n=441). Aucun écart n'a été noté dans la distance moyenne de déplacement entre la remise à l'eau et la recapture pour les petits individus (<81 cm) et les grands (≥81 cm), ce qui aurait été le cas s'il y avait eu dispersion des juvéniles. Tous les rapports de recapture contenant des renseignements sur le lieu (latitude et longitude ou zone de l'OPANO, n=466) indiquaient des lieux dans l'unité de gestion, à l'exception de sept rapports du golfe du Saint-Laurent, de trois rapports du golfe du Maine, de deux rapports d'Islande et d'un au large de l'île de Baffin. Le maintien du flétan dans l'unité de gestion contribue à la définition du stock actuel.

INTRODUCTION

In 2006, Fisheries and Oceans Canada (DFO) and the Atlantic Halibut Council (AHC) began the Halibut All Sizes Tagging (HAST) program to estimate exploitation rate, describe the movement and distribution of halibut within the Scotian Shelf-southern Grand Banks management unit (NAFO Divs. 3NOPs4VWX5Zc), and estimate population size. Between 2006 and 2010, Atlantic Halibut (*Hippoglossus hippoglossus)* were double tagged with t-bar anchor tags primarily during the DFO-Industry Halibut Survey (May - July). An earlier tagging study (yellow tag program 1995-2009), where fisherman tagged halibut that were not large enough to be of commercial value (< 81cm) throughout the year, is not included in this report, but the HAST tagging program benefited from lessons learned from that earlier study. There have also been 17 pop-up archival transmitting tag (PAT) deployments on Atlantic Halibut between 2007 and 2010 to investigate movement, behaviour and habitat preference. The analysis of the PAT data will be presented in another publication.

Tagging programs generally rely heavily on support from the fishing industry. The HAST program is an example of industry support, in that the AHC has been involved in its design, implementation, and management. Without this cooperation as scientific partners, this project would not have been possible. Tagged halibut were released by onboard fisheries observers during the DFO-Industry Halibut Survey and the AHC compensated fishermen for releasing those halibut large enough to be retained and sold (≥81cm). For each tagged halibut recaptured, the AHC also provided a $100 cash reward and an entry into a quarterly $1000 lottery.

Here we provide a general overview of the program, including a review of the database and a summary of the data. Using a multiyear tagging model that incorporates tag loss and allows for incomplete mixing in the first year (den Heyer et al. 2011), we estimate natural and fishing mortality, and tag loss between 2006 and 2010. We also describe the growth and movement of halibut tagged on the Scotian Shelf and southern Grand Banks.

METHODS

DATA COLLECTION

Tagging Program Design

To achieve broad coverage of the entire Scotian Shelf and southern Grand Banks management area, the DFO-Industry Halibut Survey (Trzcinski et al. 2011) was used as the platform for tag deployment. A sample size of 700 was chosen to achieve estimates of exploitation rates with roughly a 10% coefficient of variation (CV) for the expected exploitation rate of 0.1 to 0.2. The average number of halibut caught on the halibut survey from 1998 to 2005 was 645 (SE=31). For this reason, all halibut caught on the survey were tagged and released until a sample size of 700 was reached. If this number was not reached during the survey, halibut continued to be tagged during the Halibut Commercial Index sets (Trzcinski et al. 2011) and the commercial fishery.

The number of tags assigned to each NAFO division in the management area was proportional to halibut abundance estimated from catch rates in the halibut survey. A Delaunay triangulation (Watson 1994) of the survey catches from 1999-2005 was used to generate an approximation of the area fished (Fig. 1). The area fished was subdivided into sampling polygonal areas for each of the six NAFO divisions. The CPUE for each of the NAFO divisions, *i*, was multiplied by the

area of each of the sampling polygons to generate the area proportion of abundance in each division (eq. 1, Table 1).

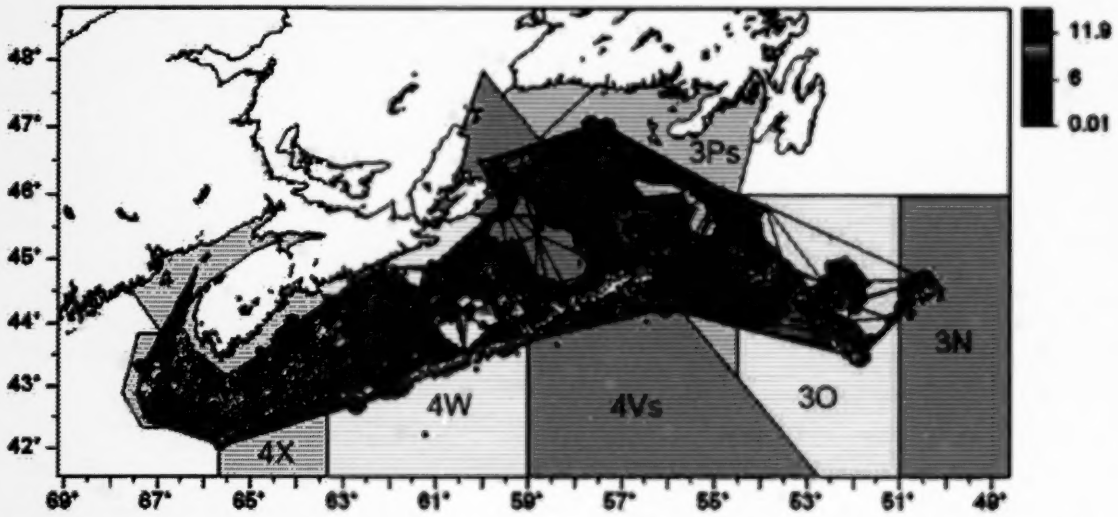

Figure 1. Spatial expansion of halibut survey catch rates (colored legend) using Delaunay triangulation of from 1999 to 2005 overlayed on a map of NAFO areas.

$$\%Tags_i = \frac{Area_i CPUE_i}{\sum Area_i CPUE_i} \qquad (1)$$

Table 1. NAFO area proportion of abundance and the number of halibut to be tagged per NAFO division ±10% estimated using Delaunay triangulation.

	NAFO AREA						
	3N	**3O**	**3Ps**	**4V**	**4W**	**4X**	**Total**
Proportions of tagged halibut	0.08	0.10	0.19	0.24	0.24	0.14	1.00
Allocation for 700 halibut	54 (±5)	71 (±7)	134 (±13)	171 (±17)	169 (±17)	101 (±10)	700 (±69)

To estimate tag loss, all halibut were double tagged. To ensure a high tag reporting rate, participants were rewarded with $100 and a ballot in a quarterly $1000 lottery.

In 2006, fishing gear conflicts at the regularly fished survey locations and restriction on commercial fishing in 3Ps prevented the capture of an adequate number of halibut for tagging in this NAFO division. To resolve this problem in subsequent years, additional stations were fished in a defined area, known as the 3Ps Box (Fig. 2).

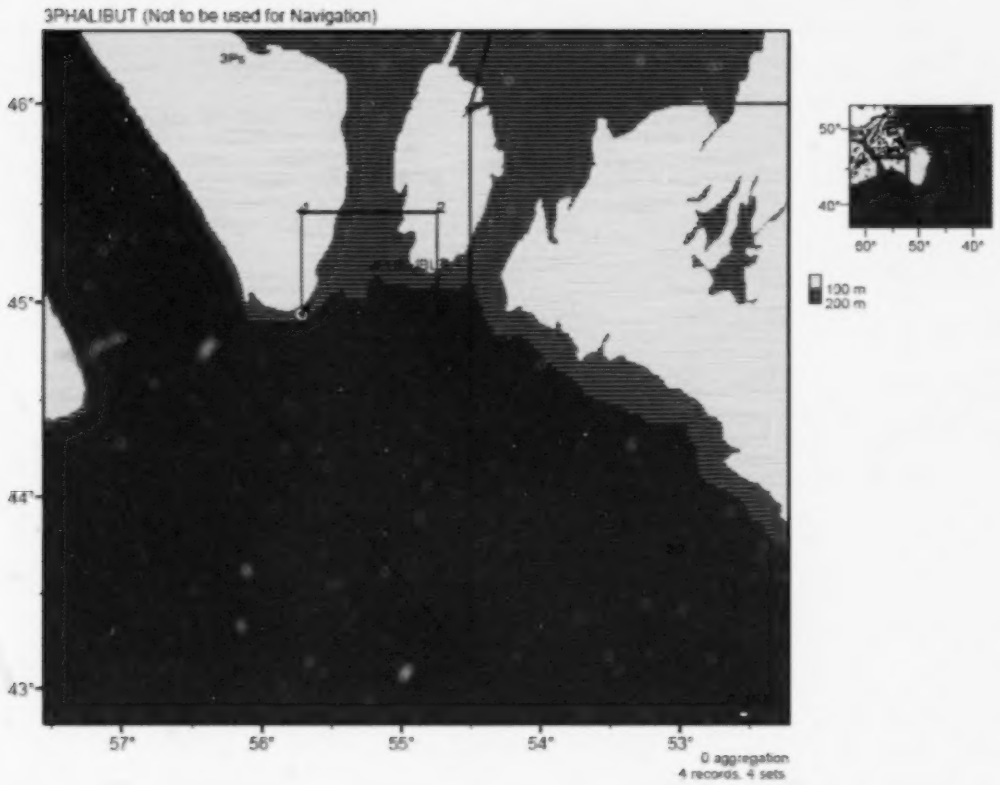

Figure 2. Atlantic Halibut tagging box in NAFO division 3Ps. The four corners that delineate the box are: 1) 55˚42´38˝ W, 45˚27´37˝ N; 2) 54˚44´15˝ W, 45˚27´37˝ N; 3) 54˚44´14˝ W, 44˚56´26˝ N; 4) 55˚42´38˝ W, 44˚56´26˝ N.

Tag Releases

Between 2006 and 2010 (no tagging in 2009, program has changed to tagging in alternate years), Atlantic Halibut were double tagged with uniquely coded pink t-bar anchor tags (Hallprint Pty Ltd., Australia) applied 15 cm apart at the widest point near the dorsal fin on the dark or top side (Fig. 3). Observers were asked to apply the first tag applied in the anterior tag and the second tag in the posterior tag. Tagged halibut were returned to the water immediately.

Figure 3. Photograph of pink t-bar anchor tags applied 15 cm apart at the widest point near the dorsal fin of Atlantic Halibut.

Observers were asked to tag only fish they felt had a high probability of survival; fish that were not active or less active than average were not tagged. Fish that were not suitable for tagging but were of commercial value (above the legal size limit, ≥ 81 cm) were retained for sale. Fishermen were compensated for the release of commercially valuable halibut by the AHC using a predetermined market value. The round weight (lbs) was estimated using a length/weight conversion developed from the lengths (cm) and weights (lbs) of halibut caught at the fixed stations from 1998 to 2005 (eq. 2).

$$\text{Round weight} = 0.0114 \cdot \text{length}^{3.007} \qquad (2)$$

Tagged Atlantic Halibut were caught by bottom longline gear during the halibut survey, the commercial index or commercial fishing while being observed by Canada's At-Sea Observer Program. While commercial index and commercial fishing methodology varies, the halibut survey has standardized hook size and type (#14 circle hooks). A set is considered to be 1000 hooks set for 6 to 12 hours. Observers recorded release information including date, location, tag numbers and tag positions (posterior or anterior), total length and morphology codes that described fish health (Table 2) and hook injuries (Table 3). This data was entered into DFO's Industry Surveys Database (ISDB).

Table 2. General health rating (Morph Code 48 in ISDB).

Rating	Condition	Description
0	Unable to determine	
1	Alive – No injury	No sign of stress
2	Alive – Injured	Alive but showing signs of stress
3	Dead	Dead
5	Moribund	No sign of life / likely to die of severe injuries

Table 3. Hook removal injury rating (Morph Code 81 in ISDB).

Rating	Condition	Description
0	Unknown	Unknown or unrecorded
1	Minor	No apparent injury; Torn lip; small hole through cheek
2	Moderate	Torn jaw; Cheek and jaw; Hook penetrates eye
3	Severe	Torn face; Split jaw; Torn snout

Tag Recaptures

Posters announcing the HAST program and the reward for returned tags were distributed throughout Atlantic Canada (Appendix A). Fishermen and fish processors were asked, where possible, to report the tag number(s), date, location, length and sex of tagged halibut caught during commercial fishing or industry surveys. Fishermen, observers, and processors were provided tag envelopes to encourage collection of information. In 2010, the tag envelope (Appendix B) was modified to encourage collection of additional information (e.g., gear used). For each tagged halibut reported, the person who reported the tag or tags was sent a letter and a map indicating the net movement and the tag release and recapture locations, a $100 reward for each tagged halibut (with either one or two tags), and, for new participants, an AHC ball cap. In 2010, the automated report letter was edited to accommodate multiple returns from the same fishermen (Appendix C), prior to that, the letter was edited or several letters printed. In addition to these incentives, each returned tag was provided a ballot for a quarterly lottery for $1000. Entries into the quarterly draw do not expire until the name is drawn. Any name that is drawn for a second time in a year or in a consecutive draw is returned to the ballot box, and another name is drawn. Notably, lottery entries were provided to tag returnees from both the HAST program and the earlier juvenile (yellow tags) tagging program.

DATA MANAGEMENT

Database Description

Data management is an important component of a tagging program. Because halibut tagging occurs during the DFO-Industry Halibut Survey, tag release information is entered into DFO's Industry Surveys Database (ISDB). An event-based tagging database was developed at DFO to house the release data extracted from the ISDB and the recaptures reported by the fishing industry. The event-based approach was taken to accommodate all tag types and combinations deployed as well as the variety of fates of the tagged halibut. The event codes (Table 4) allow for the creation of views that link release and recapture information for individual fish.

Table 4. Definition of events (EVENTTYPE_ID) in the halibut tagging database.

EVENTYPE_ID	Description
1	tagged and released
2	recaptured
3	re-released
4	re-released with new tag
5	reported but tag not returned

The halibut_temp_tag database consists of four data tables and ten code tables (Fig. 4, Appendix D). The EVENTS table has information on location and individual information at time of the event for each tag. Notably, the halibut tagging database currently does not include information on the position of the tags when applied or the condition of the fish at time of release (ISDB morph codes 48 and 81, Table 2 & 4). The TAGS table has information on the tag and project with which the tag is associated. The ANIMALS table has species and sex information on the tagged animal. The TRIPS table contains detailed information on deployment trips extracted from ISDB and trip details provided with tag reports. We have accessed data from the ISDB and copied it to the EVENTS table. There are tags for which the fate is unknown, which in most cases were either broken or were the end of a series and not deployed. In the long-term the TAGS table should include tag fates or status, e.g. deployed, not used, damaged, returned.

ISDB_HALIBUT Tables

TEMP_TAG_EVENTS
EVENT_ID
TAG_ID
EVENTTYPE_ID
ANIMAL_ID
CONTACT_ID
DATASOURCE_ID
DATASOURCE_KEY
TRIP_ID
SET_NO
GEAR_ID
PORT
YEAR
MONTH
DAY
TIME
LAT_DEG
LAT_MIN
LAT_SEC
LON_DEG
LON_MIN
LON_SEC
MIN_DEPTH
MAX_DEPTH
NAFO_ID
LOCATION
LENGTH
WEIGHT
SEX_ID
COMMENTS
DATE_LAST_MODIFIED

TEMP_TAG_TAGS
TAG_ID
TAG_NO
TAGTYPE_ID
PROGRAM_ID
TAGPREFIX
TAGCOLOUR_ID
DATASOURCE_ID
DATASOURCE_KEY
INITIALDEPLOY
FINALRETURNDATE
RETENTION
LOCATION
REWARD
COMMENTS
DATE_LAST_MODIFIED

TEMP_TAG_TRIPS
TRIP_ID
TRIP_NAME
VESSEL_ID
SETRANGE
BOARD_DATE
LANDING_DATE
CONTACT_ID
DATASOURCE_ID
DATASOURCE_KEY
PICONTACT_ID
COMMENTS
DATE_LAST_MODIFIED

TEMP_TAG_ANIMALS
ANIMAL_ID
SPEC_ID
SEX_ID
DATASOURCE_ID
DATASOURCE_KEY
COMMENTS
DATE_LAST_MODIFIED

Figure 4. The four tables in the event-based halibut_temp_tag database.

The halibut tagging database also contains several releases that were not entered into ISDB. These are identified as DATASOURCE_ID=2 in the EVENTS table. Some of these rows of data (EVENTYPE_ID=1) were created as place holders during the development of the database and are not included in the present analysis. Most of this data is from one trip (J10-249A) where the release information was not recorded on the observer forms and for which we do not have individual length or weight data, but we do know the day and NAFO area of release. Releases for which we have no records, but were created to match tags reported recaptured (place-holders), should be removed from the halibut_temp_tag database.

Data Editing

Several queries were used to check the release data (Table 5). At present, the ISDB and halibut_temp_tag database are not linked and edits are completed in both databases. A log of halibut_temp_tag database edits is being kept. In the long-term, we need to link the halibut_temp_tag database with the ISDB such that tagging data is updated when there are edits to the ISDB.

Table 5. List of data checking queries for release data.

Queries
Check position information: minutes, and seconds do not exceed 60
Length and weight data: plot length vs. weight to identify outliers
Identify missing prefix codes
Identify duplicated tag numbers
Confirm that the fish length, weight, set depth and location information is duplicated for both tags applied to a fish

Tag reports are entered directly into the halibut_temp_tag database. There is no query of ISDB for recapture of tagged halibut. It is possible that the recapture of some tagged halibut occurs during observed trips and are recorded in ISDB. These reports may have more complete recapture information and could be used to check and supplement the tag reports. We need to develop queries for tag reporting in ISDB. Also, we need develop data editing procedures to add new data and deal with common problems in the halibut tagging database. The following data management rules have been established to deal with the most common problems:

- Tag reported from a fish that was already recaptured: data entered with notes.

- Missing date, prefix, color, or location information: if contact information is available, fishermen are contacted to see if more details are available. When possible, the appropriate prefix can be identified by the tag number. Returns from the older tagging study (yellow tags) are recorded in a separate Excel data file.

- Two tags reported from same fish, but according to the database these tags were deployed on different fish: check for notes on the deployment trip, use length at deployment and return to resolve fish if sufficient information is available, enter information and add note to comment field.

- One tag reported and fish released with second tag: this is entered with appropriate event code. Only first recapture used in the following data summary.

- Tag lengths and weights are taken with and without the head and before and after dressing. At present the data are converted to round weight using the following conversions (weights multiplied by 1.2 for head off or 1.4 for head off, gutted; no conversion for lengths). The database would be improved if we recorded the measurement with and without the head and before and after dressing as well as the estimated weight.

Several queries were used to check the release data (Table 6).

Table 6. List of data checking queries for release data.

Queries
Check position information: degrees, minutes, and seconds do not exceed 60
Length and weight data: plot length vs. weight to identify outliers
Confirm tag returns are from the same fish
Confirm all fish reported with two tags have same recapture information, including date, sex, length, weight and location information

STATISTICAL ANALYSIS

Basic statistical analyses such as maps, histograms and linear regressions were produced in R version 2.13.0 (R Development Core Team 2011). Unpaired t-tests were used to compare mean displacement distances and mean lengths.

M and F Estimates

The HAST tagging experiment is an example of a band-recovery experiment as exemplified by Brownie et al. (1985). While the Brownie et al. (1985) models are commonly applied to bird studies, Hoenig et al. (1998a) demonstrated how to re-parameterize the Brownie et al. (1985) models in terms of parameters commonly used in fisheries management (i.e. instantaneous survival and fishing mortality). Natural (*M*) and fishing (*F*) mortality were estimated from a multiyear mark-recapture analysis that allows for incomplete mixing in the first year post release (Hoenig et al. 1998b). The model, which also estimates tag loss is described in detail in den Heyer et al. (2011). Here, we run the model for 2006 to 2010 using releases of all halibut excluding releases in 2010, and releases from trip J07-0354, for which the release information was poorly recorded. As with earlier analysis, the models are run for a range of reporting rates (0.9 and 1.0) and a range of initial tagging survival (0.7, 0.8, 0.9, and 1.0).

Growth

Annual growth (G, cm•year^{-1}) of halibut between release and recapture was estimated using the difference in length between release (L_{rel}, cm) and recapture (L_{rec}, cm) divided by days at large (dal) multiplied by 365 days•year^{-1}.

$$G = (L_{rec} - L_{rel}) / dal \bullet 365 \qquad (3)$$

Movement

The diffusion null hypothesis is that the direction of movement is random. A Rayleigh test of the mean vector, ρ (eq. 3), was used to test for a random distribution of directions (Batschelet 1981) of displacement distance between capture and release sites with tags and release with tags and recapture. The Rayleigh test was completed using CircStats package (Lund 2001).

$$\rho = 1 \bullet n^{-1} \bullet [(\sum \cos \theta)^2 + (\sum \sin \theta)^2)]^{1/2} \quad (4)$$

RESULTS

TAG RELEASES

There were 2,771 halibut tagged and released between 2006 and 2010 (Table 7), on 69 trips that were completed on 27 different boats with 31 observers.

Table 7. Number of tagging trips, boats, and observers that participated in the HAST tagging, and the number of tagged halibut released in each year between 2006 and 2010.

	2006	2007	2008	2010
Trips	17	16	18	18
Boats	11	13	17	14
Observers	9	13	10	9
Halibut tagged	526	830	708	707

The morph codes indicating general health and hook removal for all HAST tags deployed in 2006, 2007, 2008 and 2010 were accessed in ISDB. Morph Code 48 was not recorded for 7% of the tagged halibut. Of those assessed, 97% had no signs of injury (Table 8). For 87% of the halibut released the hook removal injury was recorded and for 95% of those assessed the injury was minor (Table 9). Notably 2 tagged fish were recorded as dead and another as moribund.

Table 8. General health rating (Morph Code 48 in ISDB) of tagged and release halibut.

Rating	Condition	Description	Count	Percent
0	Unable to determine		2	0.08
1	Alive – No injury	No sign of stress	2493	96.78
2	Alive – Injured	Alive but showing signs of stress	78	3.03
3	Dead	Dead	2	0.08
5	Moribund	No sign of life / likely to die of severe injuries	1	0.04
Total			2576	

Table 9. Hook removal injury rating (Morph Code 81 in ISDB) of tagged and release halibut.

Rating	Condition	Description	Count	Percent
0	Unknown	Unknown or unrecorded	1	0.04
1	Minor	No apparent injury; Torn lip; small hole through cheek	2282	95.52
2	Moderate	Torn jaw; Cheek and jaw; Hook penetrates eye	99	4.14
3	Severe	Torn face; Split jaw; Torn snout	7	0.29
Total			2389	

Poor data recording on 2 trips (J07-0354 and J10-0249A) makes it impossible to associate tags with individual fish, hence these releases cannot be used in analysis of tag loss, and recapture or movements associated with fish length. Excluding these two trips, there were 2546 tagged halibut released, primarily during the halibut survey in June and July (Tables10 and 11).

Table 10. The number of halibut tagged and released as part of the all-sizes tagging program by month between 2006 and 2010 (n=2546).

Month	2006	2007	2008	2010	Total
4	0	0	99	0	99
5	11	164	71	68	314
6	254	0	441	390	1085
7	218	505	96	130	949
8	43	11	0	45	99
Total	526	680	707	633	2546

Table 11. The number of halibut tagged and released as part of the all-sizes tagging program by NAFO between 2006 and 2010 (n=2546). The proportion of tags allocated was defined area proportion of abundance (eq.1), and the proportion of total tags deployed was calculated for the sum of all years.

NAFO	Proportion Allocated	2006	2007	2008	2010	Total	Proportion of Total
3N	0.22	93	54	54	55	256	0.10
3O	0.13	32	57	58	71	218	0.09
3Ps	0.19	30	237	143	134	544	0.21
4V	0.19	103	116	185	126	530	0.21
4W	0.16	165	132	166	140	603	0.24
4X	0.12	103	84	101	107	395	0.16

Tagged halibut were released throughout the management unit (Fig. 5). The halibut tagged and released in NAFO Subarea 3 were significantly (t=19.87, df=1945, p<0.001) larger (mean 115 cm, n=1018) than the halibut released in NAFO Subarea 4 (mean 94 cm, n=1528) (Fig. 6).

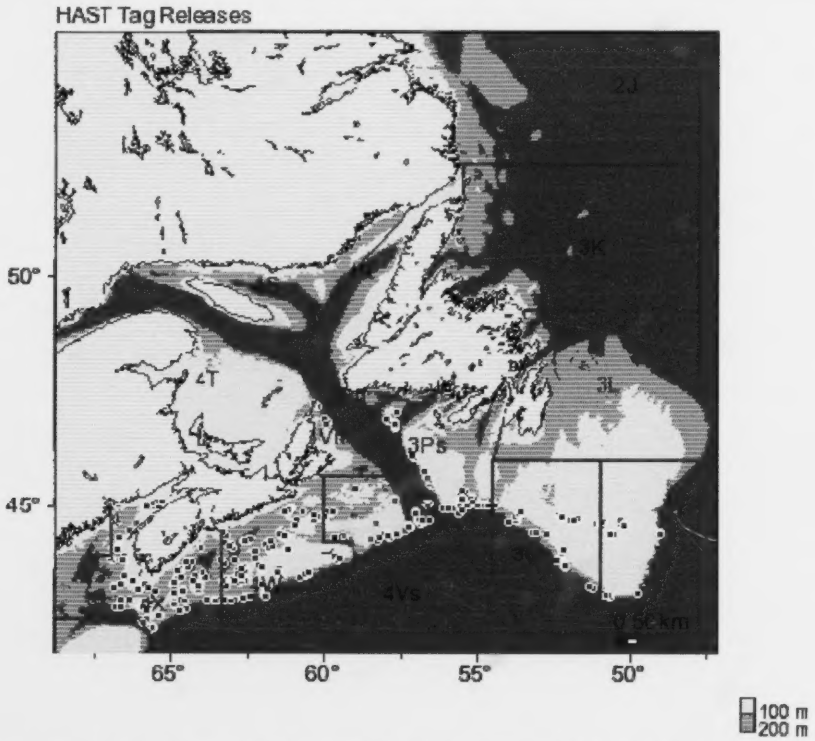

Figure 5. Map of location of tagged halibut released between 2006 and 2010.

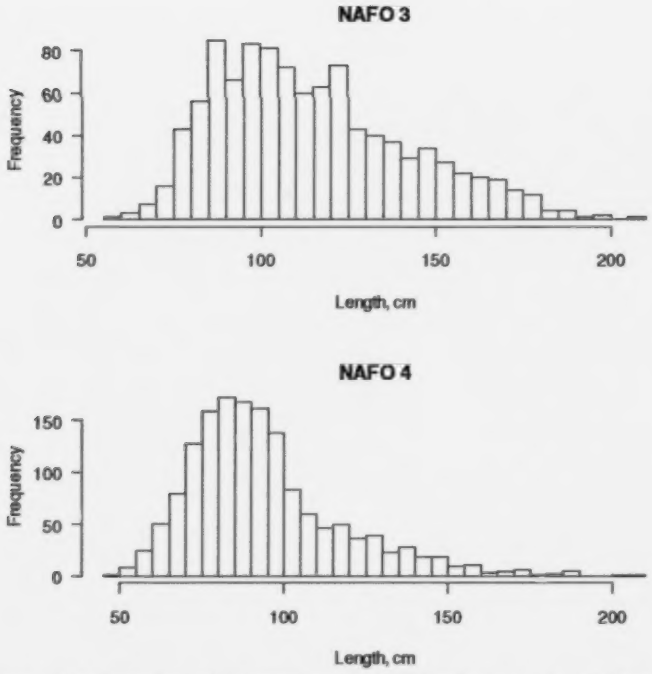

Figure 6. Frequency histograms of length at time of release for halibut released in a) NAFO Subarea 3 (n=1018) and b) NAFO Subarea 4 (n=1528).

TAG RECAPTURES

As of February 27, 2012, 969 tags had been reported. For 955 of these tags we know the position of deployment, 481 were attached in the anterior position and 474 were attached in posterior position.

There were 231 participants, 75% of whom reported 4 or fewer tag recaptures, but one participant reported the recapture of 86 tags. Of the 584 tagged halibut recaptured and reported, just over 1% were re-released with one, two or different tags (Table 12). It is not known if the 2 animals that were re-released with new tags (EVENTTYPE_ID=4) were recaptured, as the tag number and type of the re-release are not recorded in the database. One halibut was recaptured after re-release, but only the first recapture is included in the summaries and analysis below. Further, all releases and reports from the trips with poor record keeping (J07-0354 and J10-0249A, n=255) have been removed. The proportion of halibut recaptured for each release trip varied between 0 and 46%, with the earlier tagging trips having a higher proportion returned (Table 13).

Table 12. Summary of the number of halibut recaptured and re-released.

EVENTTYPE_ID	Description	Number
2	recaptured	575
3	re-released	5
4	re-released with new tag	2
5	reported but tag not returned	2
TOTAL		584

Table 13. Number of halibut released (N Rel) and recaptured (N Recap) for each release trip.

TRIP	N Rel	N Recap	Prop.	TRIP	N Rel	N Recap	Prop.
J06-0097	29	13	0.45	J08-0041	99	11	0.11
J06-0163A	64	15	0.23	J08-0200	74	20	0.27
J06-0163B	12	1	0.08	J08-0201	130	22	0.17
J06-0172	18	5	0.28	J08-0202	20	3	0.15
J06-0179	32	8	0.25	J08-0203	8	1	0.12
J06-0181	3	1	0.33	J08-0204	32	7	0.22
J06-0182	31	7	0.23	J08-0205	35	1	0.03
J06-0183	26	12	0.46	J08-0206	16	5	0.31
J06-0184	14	6	0.43	J08-0207	15	5	0.33
J06-0210	56	18	0.32	J08-0209	7	2	0.29
J06-0237	9	2	0.22	J08-0211	43	4	0.09
J06-0250	15	6	0.40	J08-0212	11	2	0.18
J06-0251	125	18	0.14	J08-0271	39	11	0.28
J06-0270	20	3	0.15	J08-0281	14	0	0
J06-0276	12	5	0.42	J08-0302B	82	19	0.23
J06-0324	17	2	0.12	J08-0303A	27	7	0.26
J06-0432	43	7	0.16	J08-0305	22	2	0.09
J07-0150	164	39	0.24	J08-0316	33	7	0.21
J07-0295	140	51	0.36	J10-0137A	33	4	0.12
J07-0296	41	4	0.10	J10-0138A	35	3	0.09
J07-0297	16	5	0.31	J10-0212A	27	2	0.07
J07-0312	24	6	0.25	J10-0212B	35	3	0.09
J07-0313	136	57	0.42	J10-0215	24	3	0.12
J07-0317A	24	8	0.33	J10-0280	153	17	0.11
J07-0355	12	3	0.25	J10-0281	30	2	0.07
J07-0387	18	2	0.11	J10-0282	22	2	0.09
J07-0388	7	3	0.43	J10-0283	15	4	0.27
J07-0402	20	7	0.35	J10-0284	10	0	0
J07-0403	34	8	0.24	J10-0285	6	0	0
J07-0411	22	5	0.23	J10-0286	18	3	0.17
J07-0425	11	0	0	J10-0287	15	2	0.13
J07-0493	11	2	0.18	J10-0290	65	3	0.05

TRIP	N Rel	N Recap	Prop.
J10-0292	35	6	0.17
J10-0345	65	1	0.02
J10-0397B	45	2	0.04

Of the 515 halibut recaptured from releases between 2006 and 2010 (n=2546, excluding J07-0354 and J10-0249A), 347 were reported with both tags. Sex was reported for 278 of these halibut: 131 male and 147 female. On average, the male halibut were 98 cm (range 64 to 162) at time of release and the females were significantly larger ($t=-8.61$, $df=249$, $p<0.001$) with a mean of 123 cm (range 57 to 194).

Length at time of recapture was reported for 376 recaptured halibut. Of those, only 261 reports were for a recapture length greater than release length, suggesting that it may be fairly common for measurements to be made after the fish has had the head removed and/or was gutted.

The complete date of recapture was reported for 467 of the halibut recaptured. Recaptures occur year round, although most frequently in June and July (Table 14).

Table 14. Number of halibut recaptured by month in each year (n=467).

Month	2006	2007	2008	2009	2010	2011	2012	Total
1	0	5	13	12	4	3	0	37
2	0	4	12	10	13	9	0	48
3	0	6	4	13	6	7	0	36
4	0	1	4	4	11	9	0	29
5	0	2	4	14	2	0	0	22
6	1	5	35	24	13	7	0	85
7	1	13	33	17	11	3	0	78
8	3	8	16	11	18	3	0	59
9	5	4	10	4	8	3	0	34
10	3	5	2	2	3	1	1	17
11	2	1	6	1	1	0	0	11
12	1	0	5	2	1	2	0	11

The NAFO Division of recaptured halibut was reported or could be assigned based on the location for 444 recaptures. Most (98%) of the tagged halibut were recaptured within the management unit (NAFO Divs. 3NOPs4VWX5Zc, Table 15). Three have been caught in the Gulf of Maine (NAFO 5Y), 7 were recaptured in the Gulf of St. Lawrence (4R and 4T), 1 off of Baffin Island (0B) and 2 near Iceland (included in other) (Fig. 7).

Table 15. The number of halibut recaptured by NAFO Division for each year.

NAFO Division	2006	2007	2008	2009	2010	2011	2012	Total
Within the management unit								
3N	1	0	3	2	14	2	0	22
3O	0	9	44	5	5	1	0	64
3P	2	10	28	34	23	15	0	112
4V	1	10	28	28	17	9	0	93
4W	3	13	16	18	19	6	0	75
4X	6	10	15	16	8	11	1	67
Total								433
Outside of the Management Unit								
0B	0	0	0	1	0	0	0	1
4R	0	1	1	0	0	0	0	2
4T	3	0	1	1	0	0	0	5
5Y	0	1	0	2	0	0	0	3
Iceland	0	0	2	0	0	0	0	2
Total								13
Not reported								21
Grand total								467

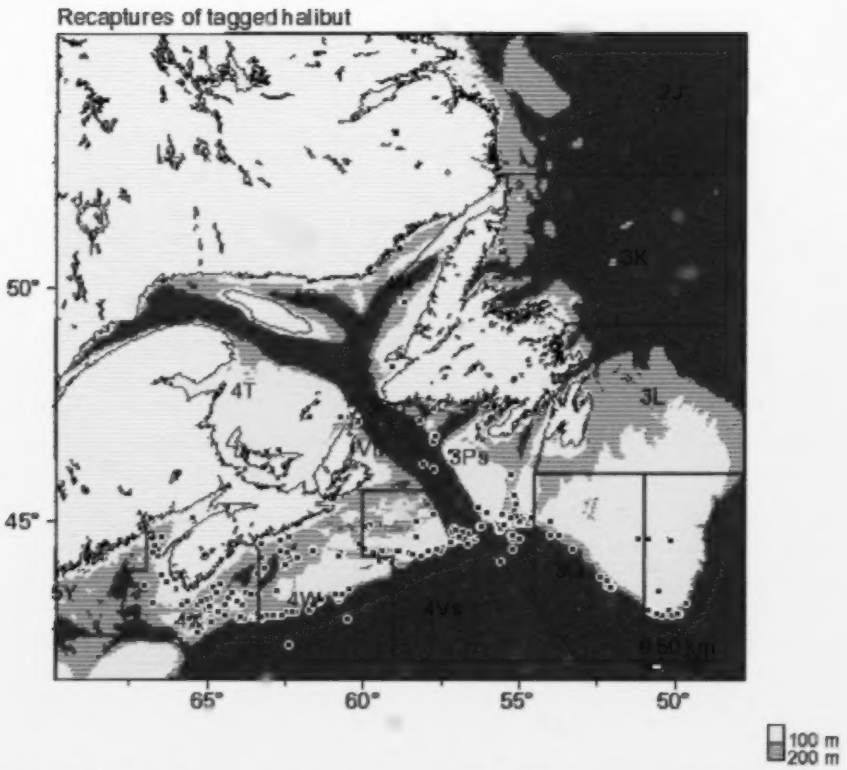

Figure 7. Map of the location of recaptured tagged halibut between 2006 and February 2012 (n=441). Three recaptures, 1 off of Baffin Island and 2 near Iceland are not plotted.

M AND *F* ESTIMATES

Between 2006 and 2008, 1913 halibut were tagged and released, 400 of which were reported recaptured between 2006 and 2010 with sufficient information to be included in the mark-recapture analysis (Table 16). Except for the estimated tag-loss rate for 100-200 days-at-large, based on few recaptured fish, estimates of cumulative tag-loss rate increased over time but plateau at about 25% tag loss after about 1 year-at-large (Fig. 8).

Table 16. Summary of recovery data. Each cell has two entries. The first entry is the number of fish with a single tag recovered; the second entry is the number of fish with both tags recovered, regardless of location on the fish. All fish released had two tags. Pooled over all lengths at release, all areas released, areas recovered, etc. Year classes are calendar years.

Year of Release	Number Released	Year of recovery				
		2006	2007	2008	2009	2010
2006	526	1 / 15	13 / 26	9 / 16	6 / 13	4 / 11
2007	680		4 / 11	28 / 70	16 / 26	12 / 13
2008	707			2 / 19	12 / 41	16 / 16

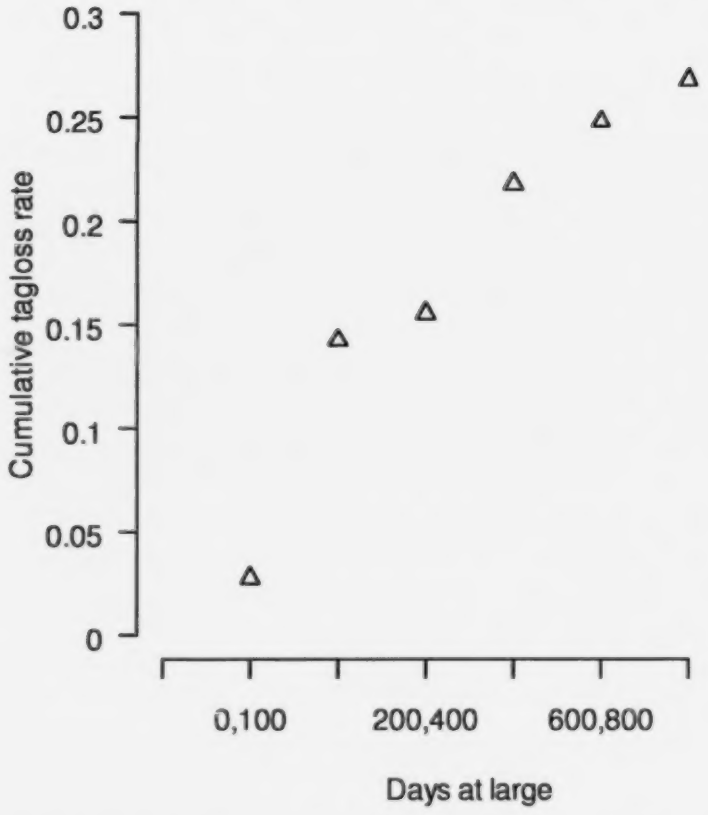

Figure 8. Estimated cumulative tag loss rates calculated for each time interval; 1-100 (n=37), 101-200 (n=20), 201-400 (n=130), 401-600 (n=67), 601-800 (n=73), and 801-1200 (n=52) days. 21 reports were excluded because days at large was outside of the 0 to 1200 days at large.

Initial tagging survival (ITS) and reporting rate (RR) are theoretically possible to estimate (Hoenig et al. 1998a), but our data is too sparse to estimate these parameters so we have chosen a range of fixed values. The range of ITS was chosen to bracket the estimates of discard survival of Atlantic Halibut from a holding tank by Neilson et al. (1989), where a mortality rate of 23% was observed, and a captive study of Pacific Halibut to assess tagging mortality by Peltonen (1969) that estimated 3.8% mortality over a 14-day period under reasonably good conditions for captivity. Based on the results of these studies, we used 0.7, 0.8, 0.9, and 1.0 for ITS in our model fitting. As our tagging protocol selects for individuals without serious injury at the time of release, we consider 80% initial tagging survival a reasonable estimate. We have also presented models with reporting rate (RR) of 0.9 and 1.0. The support of the AHC, the $100 reward and lottery entry for each return should be sufficient incentive to produce a very high reporting rate. Commonly, $100 rewards are assumed to have 100% reporting in studies of reporting rate with high and low reward tags. Nonetheless almost 10% of tag reports are not included in the analysis because insufficient information supplied about recapture, either because of poor record keeping or the tag was not noticed during fishing and instead was recovered at port. Therefore, we us 0.9 as the preferred estimate of reporting rate.

Estimates of annual survival are robust to different assumptions of initial tagging mortality (ITS) or reporting rate (RR) as well, but the partitioning between natural and fishing mortality are sensitive to the assumptions made about ITS and RR. As seen in Table 17, estimates of natural

mortality vary considerably among the models fit with little ability to distinguish among these models (the AICc values are essentially all the same). Assuming 90% tag reporting and 80% survival from tagging, average instantaneous natural mortality (M) for halibut was estimated to be 0.16 (SE=0.07), and instantaneous fishing mortality (F) was estimated to be 0.15 (SE=0.03) in 2007, 0.22 (SE=0.03) in 2008, 0.15 (SE=0.03) in 2009, and 0.13 (SE=0.03) in 2010.

Table 17. Summary of parameter estimates using the incomplete-mixing model assuming constant natural mortality (*M*(dot)) under several scenarios for the initial tagging survival (ITS) and tag reporting rate (RR). First row in estimates of *F* represents *F** (instantaneous fishing mortality during the first 6 months after release) and the second entry represents *F* assuming complete mixing after 6 months. The model in bold is our preferred model.

	Parameter Estimates[1]								
Model	M	F^*_{2006} F_{2006}	F^*_{2007} F_{2007}	F^*_{2008} F_{2008}	F^*_{2009} F_{2009}	F^*_{2010} F_{2010}	R_1[4]	R_2	AICc
M(dot), *F*(t), *F**(t), *R*(2), ITS=0.7, RR=0.9	0.137	0.058	0.109	0.069	NA[3]	NA[3]	0.83	0.93	-1641.8
		NA[2]	0.168	0.247	0.172	0.150			
M(dot), *F*(t), *F**(t), *R*(2), ITS=0.7, RR=1.0	0.158	0.054	0.098	0.063	NA	NA	0.83	0.93	-1641.9
		NA	0.152	0.225	0.156	0.137			
M(dot), F(t), F*(t), R(2), ITS=0.8, RR=0.9	**0.163**	**0.052**	**0.095**	**0.061**	**NA**	**NA**	**0.83**	**0.93**	**-1641.9**
		NA	**0.147**	**0.219**	**0.152**	**0.134**			
M(dot), *F*(t), *F**(t), *R*(2), ITS=0.8, RR=1.0	0.182	0.048	0.085	0.056	NA	NA	0.83	0.93	-1642.0
		NA	0.133	0.199	0.138	0.122			
M(dot), *F*(t), *F**(t), *R*(2), ITS=0.9, RR=0.9	0.184	0.048	0.084	0.055	NA	NA	0.83	0.93	-1642.0
		NA	0.131	0.197	0.136	0.121			
M(dot), *F*(t), *F**(t), *R*(2), ITS=0.9, RR=1.0	0.201	0.044	0.076	0.050	NA	NA	0.83	0.93	-1642.1
		NA	0.118	0.178	0.123	0.110			
M(dot), *F*(t), *F**(t), *R*(2), ITS=1.0, RR=0.9	0.201	0.044	0.076	0.050	NA	NA	0.83	0.93	-1642.1
		NA	0.118	0.178	0.123	0.110			
M(dot), *F*(t), *F**(t), *R*(2), ITS=1.0, RR=1.0	0.216	0.040	0.068	0.045	NA	NA	0.83	0.93	-1642.2
		NA	0.106	0.162	0.112	0.100			

[1] Standard errors were computed, but are not reported here and are approximately (after adjusting for $\hat{c}$) 0.07 for M; 0.03 for F_i; 0.05 for R_i.
[2] No estimate is available for the instantaneous fishing mortality in year 1 for complete mixing (see text).
[3] No estimates are available for the initial instantaneous fishing mortality for incomplete mixing for these years because releases terminated in 2008.
[4] R_1 is the annual tag retention rate in the first year of release on an annual basis. It is prorated for the first ½ year after release in the model.

GROWTH

Of those halibut with recapture lengths greater than release lengths, we can estimate an annual growth for 243 halibut. Seven halibut, with estimated annual growth rate greater than 40 cm•year^{-1}, were removed the following analysis (Fig. 9). The mean growth per year was 8.1 cm•year^{-1}. There was no difference (t=0.29, df=147 p=0.773) between males (mean=7.9 cm•year^{-1}, n=80) and females (mean=7.6 cm•year^{-1}, n=97), but the growth rate for halibut less than a 100 cm at the time of release (mean=9.4 cm•year^{-1}, n=129) was slower (t=3.27, df=233, p<0.01) than those greater than or equal to100 cm (mean=6.6 cm•year^{-1}, n=107).

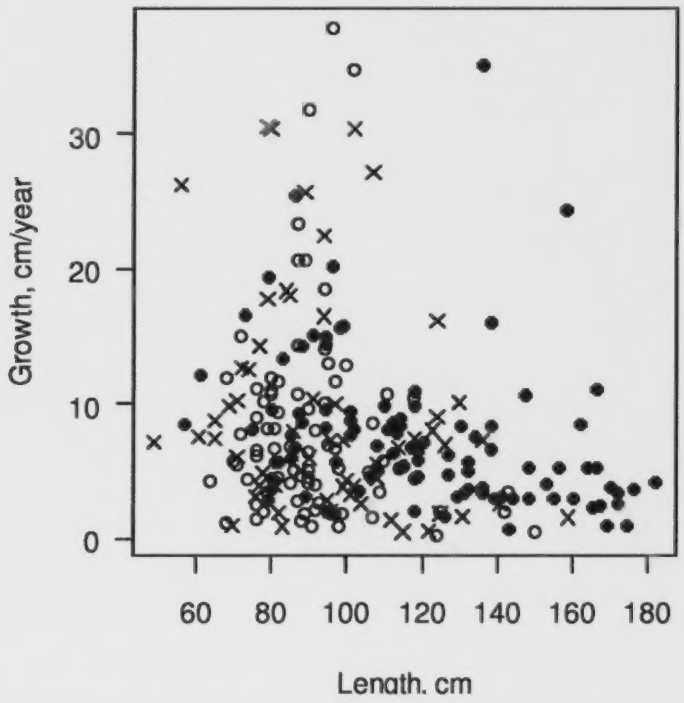

Figure 9. Plot of annual growth rate against the length at time of release. Males are indicated by the open circles, females by closed circles and unsexed fish by the x. Seven halibut with estimated annual growth rate greater than 40 cm•year^{-1} are not plotted.

MOVEMENT

The net movement between release and recapture ranges from 0 to 3140 km, with a median of 27 km (Fig 10a). Most of halibut are recaptured in the NAFO Division in which they are released (Table 18). As halibut were released during the survey and most halibut are recaptured in the summer (Table 14), days at large peaks at 1, 2 or 3 years after release (Fig. 10b). Consistent with high tag retention and the low mortality of halibut, some fish are recaptured more than 5 years after release (Fig. 10b).

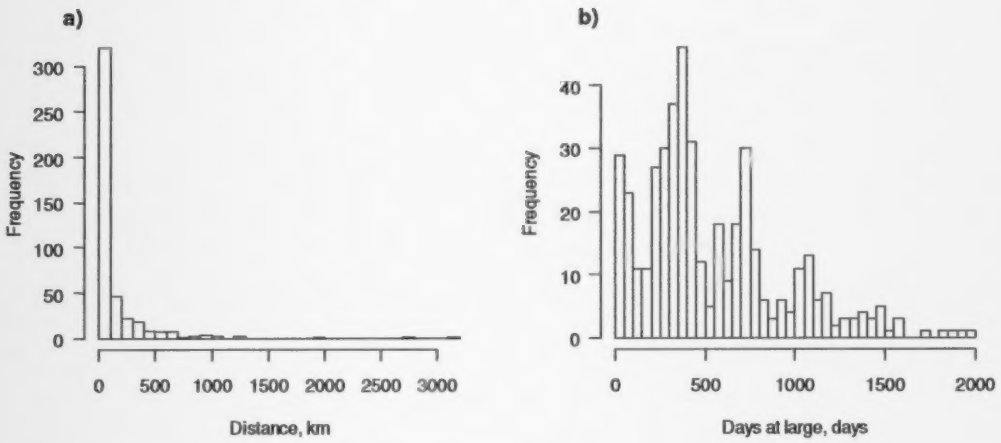

Figure 10. Frequency histograms of (a) net distance moved between release and recapture (n=441) and (b) number of days between release and recapture (n=436).

Table 18. Number of halibut released in a NAFO Division and recaptured in the corresponding NAFO Division (n=444). The cells with the greatest number of recaptures are in bold. Two reports of recaptures near Iceland are not included.

NAFO Release	NAFO Returns									
	Within Management Unit						Outside Management Unit			
	3N	3O	3P	4V	4W	4X	4R	4T	5Y	0B
3N	13	**45**	4	0	0	2	0	0	0	0
3O	4	**9**	**9**	0	0	0	1	0	0	0
3P	2	9	**81**	11	2	1	0	0	0	0
4V	0	0	4	**68**	8	0	1	5	0	1
4W	3	0	8	10	**54**	8	0	0	0	0
4X	0	1	6	4	11	**56**	0	0	3	0

The hypothesis of directional bias was not supported by a Rayleigh test of uniformity (p=0.10, n=441) although there are more movements to the east and west than north and south (Fig. 11).

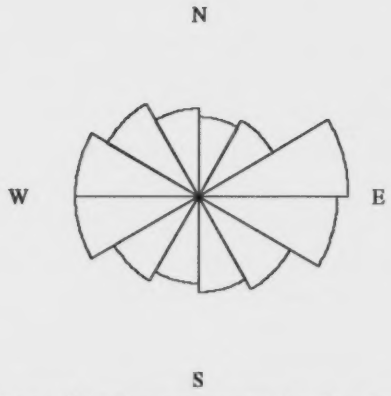

Figure 11. Roseplot of the direction of displacements of halibut tagged between 2006 and 2010 and recaptured between 2006 and February 2012 (n=436).

Stobo et al. (1988) report greater movement of juvenile (<77cm) halibut in a review of tagging studies from NAFO areas 3 and 4. We see no evidence for a difference in the net distance moved of halibut greater than and less than 81 cm (Fig. 12). Using either the Stobo definition of juvenile (77 cm) or the legal size limit (81 cm), there is no significant difference in mean distance moved for smaller and larger halibut (Table 19).

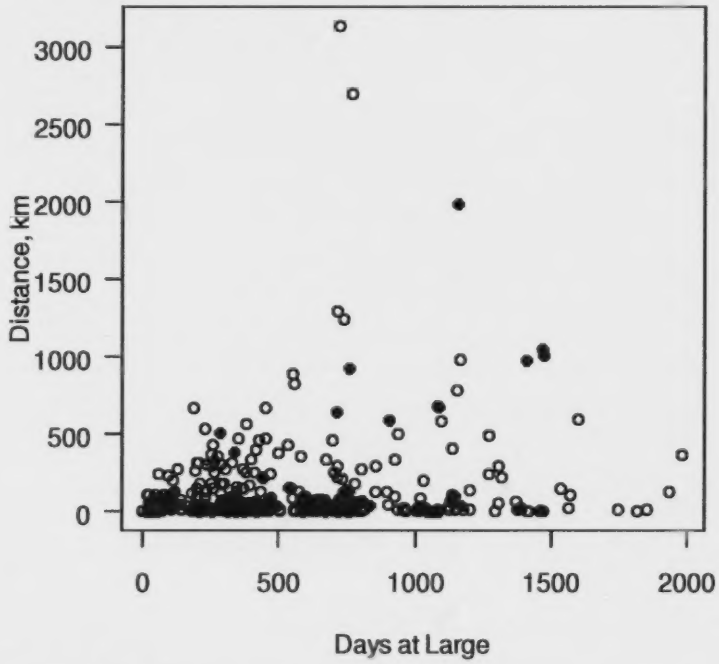

Figure 12. Plot of net distance moved (km) versus the days at larger for halibut released above 81 cm (open circles) and below 81 cm (filled circles).

Table 19. T tests for net distance moved (km) between release and recapture using 77cm and 81 cm as the cutoff for small *vs.* large halibut.

	Size			
	<77	**>=77**	**<81**	**>=81**
Mean distance (km)	138	122	163	116
n	41	395	65	371
t	0.3393		1.0172	
p	0.7385		0.3122	

DISCUSSION

The HAST program was designed to estimate fishing mortality and describe movement and distribution of halibut on the Scotian Shelf and southern Grand Banks. The program benefited from the lessons learned from previous tagging programs and has been the motivation for the development of an event-based tagging database which is still under development. The existing halibut_temp_tag database meets the current needs but database improvements are necessary. Priorities include:

- remove releases (DATASOURCE_ID=2) that were created to hold space for releases for which we have no records;
- link tagging data with ISDB such that tagging data is updated when the ISDB is edited;
- link morph codes (48 and 81) identifying position of tag and condition of fish at time of release (in ISDB) to the halibut database;
- develop data editing procedures;
- add tag fates to tags table e.g. deployed, not used, damaged, returned;
- add to events table length, weight and fish condition at time of measurement;
- develop database views and queries for data checking and report generation;
- develop queries for tag reporting in DFO observer database; and
- develop database for yellow tags.

While it is expected that most of the tags reported have been recaptured in the halibut fishery, some are also caught in other fisheries such as the otter trawl fishery. We are now asking for participants to identify the fishery in which tagged halibut have been recaptured, such that analysis of fishing mortality can be partitioned into the bottom longline and other fisheries.

The estimates of *F* and the trends over time corresponded well to those produced by the stock assessment model (Trzcinski et al. 2011). Assuming 90% tag reporting and 80% survival from tagging, average instantaneous natural mortality (*M*) for halibut was estimated to be 0.16 (SE=0.07), and instantaneous fishing mortality (*F*) was estimated to be 0.15 (SE=0.03) in 2007, 0.22 (SE=0.03) in 2008, 0.15 (SE=0.03) in 2009, and 0.13 (SE=0.03) in 2010. Despite increases in the TAC, *F* declined in 2009 and 2010, which is consistent with a recruitment pulse (Trzcinski et al. 2011). Owing to the high tag retention and the low mortality of tagged halibut, the number of tagged halibut in the water has been increasing and the precision of the mortality estimates is improving. Still, the standard errors on these estimates are large and the release of more tags in 2012 will improve the estimates.

The difference in length and between release and recapture provides longitudinal data on growth. Unfortunately, not all reports include reports of length at recapture and of those that do,

many are not believable. It may be that the lengths are taken after halibut have had heads removed and/or have been gutted. Even after removing all reports with negative growth or growth that would be greater than 40 cm•year^{-1}, we see a lot of variability in the data. Nonetheless the mean annual growth rates for fish above and below 100 cm at time of release are comparable to the estimates from aging data (Armsworthy and Campana 2010).

Although a few halibut have moved over a 1000 km, the median net movement between release and recapture is less than 30 km. We find no evidence for directional bias in the net movements, although there is a concentration of movements along the east-west axis which is consistent with a fish stock that is predominantly found along the shelf edge. Most animals released in a NAFO Division are recaptured in that NAFO Division, and overall there is very little migration out of the management unit, which supports the definition of the stock.

We do not find evidence to support the hypothesis that juvenile halibut are more mobile than adult (Stobo et al. 1988), although the HAST tagging involves larger halibut than were tagged in the earlier studies reviewed by Stobo et al. (1988). Careful consideration of the distribution of fishing effort and changes in catchability is needed to properly interpret movement from tagging data. More detailed analysis of the net movements between release and recapture, examining differences between the sexes and during different release periods, could identify annual return or dispersive movements. Further, the interpretation of the net movements will be enhanced by the analysis of the pop-up archival transmitting tags.

ACKNOWLEDGEMENTS

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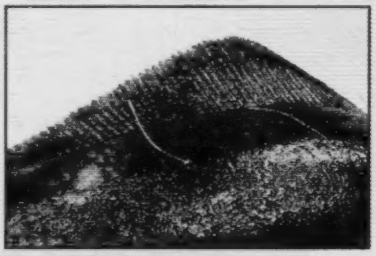
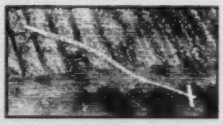
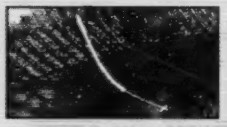
APPENDIX A. Poster.

Have You Caught a Tagged Halibut?





New!!! High Reward Tags: PINK



Original Tags: YELLOW

REWARD

- $100 per Halibut with 1 or 2 PINK tags (don't send us the fish – just the tags)
- Yellow tags and each pink tag enter you in the lotteries for $1000

$1000 lotteries are drawn 4 times per year and all entries remain for future draws

Please return tags along with the following information:

- Tag numbers
- Fish length
- Sex of fish
- Date of capture
- Location (lat/long)
- Gear
- Fishing depth
- Your name, address, and phone number

Return tags to:
Bedford Institute of Oceanography
Halibut Tagging Program
PO Box 1000
Dartmouth, Nova Scotia
B2Y 4A2

Program Coordinated Jointly by The Atlantic Halibut Council and The Department of Fisheries and Oceans

Fisheries and Oceans Canada | Pêches et Océans Canada

Canada

APPENDIX B. Tag envelope.

Fish Species:		Tag 1 Number:	
Tag Colour:		Tag 2 Number:	
Date of Capture: Day: Month: Year:			
Position of Capture: Lat: Lon:			
Position Format: (check one) DDMM'SS" L DDMM.mm' L DD.dd°L Loran-C L			
NAFO:	Place of Capture: (Ex: Brown's Bank)		
Gear Used: (check one) Longline L Gillnet L Otter trawl L Other L		Depth Fished: metres fathom	
Vessel Name:		CFV:	
Length: cm in	Weight: kg lb	Condition: (check applicable) Round L Gutted L Head Off L	
Sex:	Spawning:	Trip #:	Observed Onboard: Yes L No L
(check applicable) Re Released With Same Tag L Retagged & Re Released L			
Comments:			
(check one) Commercial Fisher L Processor L Recreational Fisher L Other L			
Name:			
Address:			
Phone/email:			

APPENDIX C. Letter to participant.

March 2, 2012

Dear ,

Thank you for reporting the recapture of a tagged halibut. This information is important for the Atlantic halibut stock assessment and in improving our understanding of Atlantic halibut population distribution and movement. A summary of the halibut movement information we have been able to establish based on your tag reports is in the table below. Also, please find enclosed a map of release and recapture locations joined by an arrow.

Tag Number	Date Released	Location Released	Date Recaptured	Location Recaptured	Time at Large	Distance
ST1347	2006/7/7	44°34.03'N, 50° 52.53'W	2011/12/11	44°48.45'N, 55° 33.7'W	5 year(s), 158 day(s)	372 km

The Atlantic Halibut Council (AHC) will be sending you a $100 reward for each ST-tagged halibut that you have reported. Each ST and yellow tag is also entered into a $1000 AHC lottery. Four winners are drawn each year and all ballots remain in the lottery (unless they are drawn). We have also enclosed a couple of tag envelopes. Should you recapture any more tagged halibut, we hope that these envelopes will help you record the valuable information and ensure that it finds its way to us.

If you have any more questions, please send us an email or note, or call Sean Smith at 902 426-2928.

Thank you for your participation.

Sincerely,

Atlantic Halibut Tagging Program
Population Ecology Division
Bedford Institute of Oceanography
PO Box 1006
Dartmouth, Nova Scotia
B2Y 4A2
Gabrielle.Wilson@dfo-mpo.gc.ca

APPENDIX D. Tables in halibut tagging database.

ISDB_HALIBUT.TEMP_TAG_ANIMALS table of tagged animals.

Column	NotNull	Indexed	Coded	Type	Size	Description
ANIMAL_ID	*	I1*1		NUMBER	20	Animals autogenerated unique primary key.
SPEC_ID	*		TEMP_TAG_SPECIESCODES	NUMBER	4	Species code for animal. References TAG_SPECIESCODES.
SEX_ID	*		TEMP_TAG_SEXCODES	NUMBER	1	Sex code for animal. References TAG_SEXCODES.
DATASOURCE_ID	*			NUMBER	6	Animal datasource id. References TAG_DATASOURCECODES.
DATASOURCE_KEY				VARCHAR2	100	Animal data source key. Eg. ISDB will be fishset_id: , catch_id: , fish_no:
COMMENTS				VARCHAR2	1000	Comments for animal. Ex. ISDB will be fish_id: .
DATE_LAST_MODIFIED				DATE	7	Date record last modified.

ISDB_HALIBUT.TEMP_TAG_EVENTS table of tagging events.

Column	NotNull	Indexed	Coded	Type	Size	Description
EVENT_ID	*	I2*1		NUMBER	28	Autogenerated unique id for event, i.e. tagging event.
TAG_ID	*	I1*1		NUMBER	24	Event tag id. References TAG_TAGS.
EVENTTYPE_ID	*			NUMBER	2	Event type id. References TAG_EVENTTYPECODES.
ANIMAL_ID	*	I1*2		NUMBER	20	Event animal id. References TAG_ANIMALS.
CONTACT_ID	*		TEMP_TAG_CONTACTCODES	NUMBER	6	Event contact id. References TAG_CONTACTCODES.
DATASOURCE_ID	*		TEMP_TAG_DATASOURCECODES	NUMBER	6	Event datasource id. References TAG_DATASOURCECODES.
DATASOURCE_KEY				VARCHAR2	100	Event data source key. Eg. ISDB will be fishset_id: , catch_id: , fish_no:
TRIP_ID		I1*3	TEMP_TAG_TRIPS	NUMBER	6	Event trip id, if known. References TAG_TRIPS.
SET_NO				NUMBER	4	Event set number, if known.
GEAR_ID			TEMP_TAG_GEARCODES	NUMBER	6	Event gear id, if known. References TAG_GEARCODES.
PORT				VARCHAR2	100	Event port, if known.
YEAR	*	I1*4		NUMBER	4	Event year.
MONTH		I1*5		NUMBER	2	Event month, if known.
DAY		I1*6		NUMBER	2	Event day, if known.
TIME				NUMBER	4	Event time, if known.
LAT_DEG	*			NUMBER	3	Event latitude degrees.
LAT_MIN				NUMBER	2	Event latitude minutes, if known.
LAT_SEC				NUMBER	2	Event latitude seconds, if known.
LON_DEG	*			NUMBER	3	Event longitude degrees.
LON_MIN				NUMBER	2	Event longitude minutes, if known.
LON_SEC				NUMBER	2	Event longitude seconds, if

Column	NotNull	Indexed	Coded	Type	Size	Description
						known
MIN_DEPTH				NUMBER	10.4	Event min depth (m), if known.
MAX_DEPTH				NUMBER	10.4	Event max depth (m), if known.
NAFO_ID			TEMP_TAG_NAFOCODES	NUMBER	3	Event NAFO id, if known. References TAG_NAFOCODES.
LOCATION				VARCHAR2	100	Event location, not NAFO (use NAFO_ID) if available. Ex. Sable Island.
LENGTH				NUMBER	10.4	Event, animal length (cm), if known.
WEIGHT				NUMBER	10.4	Event animal weight (grams), if known.
SEX_ID	*		TEMP_TAG_SEXCODES	NUMBER	1	Event animal sex id. References TAG_SEXCODES.
COMMENTS				VARCHAR2	2000	Event comments/notes.
DATE_LAST_MODIFIED				DATE	7	Date record last modified.

ISDB_HALIBUT.TEMP_TAG_TAGS table of tags.

Column	NotNull	Indexed	Coded	Type	Size	Description
TAG_ID	*	I1*1		NUMBER	24	unique by tagno, tagtypecd, programcd, prefix, colour
TAG_NO	*	I2*1		VARCHAR2	12	Tag number, i.e. serial number as visually seen on tag, note this field is text not number.
TAGTYPE_ID	*	I2*2	TEMP_TAG_TAGTYPECODES	NUMBER	6	uniqueID from types table
PROGRAM_ID	*	I2*3	TEMP_TAG_PROGRAMS_VW	NUMBER	10	uniqueID from Programs table
TAGPREFIX		I2*4		VARCHAR2	10	Tag prefix as stamped on tag. ex. ST or BLH
TAGCOLOUR_ID		I2*5		NUMBER	6	Tag colour id for physical tag colour if any Example BLH are dark pink and ST are pink. References TAG_COLOURCODES.
DATASOURCE_ID	*			NUMBER	6	Tag datasource id. References TAG_DATASOURCECODES.
DATASOURCE_KEY				VARCHAR2	100	Tag data source key. Eg. ISDB will be fishset_id: , catch_id: , fish_no:
INITIALDEPLOY				DATE	7	when provided to fisher/observer/
FINALRETURNDATE				DATE	7	null unless/until physically returned (or known disposed?)
RETENTION				VARCHAR2	100	life expectancy of tag
LOCATION				VARCHAR2	100	Current Physical Location of the tag, distributed for tagging, S Armsworthy's office, BIO
REWARD				NUMBER	5	Tag award amount, if any, NUMBER datatype (i.e. do not include characters like Dollar Symbol ($) or Commas (,).
COMMENTS				VARCHAR2	1000	Tag comments/notes
DATE_LAST_MODIFIED				DATE	7	Date record last modified.

ISDB_HALIBUT.TEMP_TAG_TRIPS table of trips involved in tagging.

Column	NotNull	Indexed	Coded	Type	Size	Description
TRIP_ID	*	I2*1		NUMBER	6	Autogenerated unique id for the trip.
TRIP_NAME	*	I1*1		VARCHAR2	15	Trip Name, ex. J09-1020.
VESSEL_ID			TEMP_TAG_VESSELCODES	NUMBER	6	Trip vessel id. References TAG_VESSELCODES.
SETRANGE				VARCHAR2	50	Trip set range, ex. 1 - 57.
BOARD_DATE	*			DATE	7	Trip boarding date.
LANDING_DATE				DATE	7	Trip landing date.
CONTACT_ID	*		TEMP_TAG_CONTACTCODES	NUMBER	6	Trip captain id. References TAG_CONTACTCODES.
DATASOURCE_ID	*			NUMBER	6	Trip datasource id. References TAG_DATASOURCECODES.
DATASOURCE_KEY				VARCHAR2	100	Trip data source key. Eg. ISDB will be fishset_id: , catch_id: , fish_no:
PICONTACT_ID			TEMP_TAG_CONTACTCODES	NUMBER	6	Trip principle investigator id. References TAG_CONTACTCODES.
COMMENTS				VARCHAR2	2000	Trip comments. Including datasource and key if applicable.
DATE_LAST_MODIFIED				DATE	7	Date record last modified.

List of codes for halibut tagging database.

Column	Description
TEMP_TAG_CONTACTCODES	List of contacts codes for taggers, returnees, observers, datasources, program, etc.
TEMP_TAG_COUNTRYCODES	List of countries. Initially populated from observer.iscountrycodes.
TEMP_TAG_DATASOURCECODES	List of data source codes for events, animals, tags and trips).
TEMP_TAG_GEARCODES	List of valid fishing gear types, initially populated from observer.isgearcodes.
TEMP_TAG_NAFOCODES	List of codes forNAFO scientific and statistical subareas (0-6), divisions and subdivisions. List obtained from NAFO website.
TEMP_TAG_PROGRAMCODES	List of tagging program codes and associated metadata.
TEMP_TAG_PROGRAMS_VW	No Comments: does VDC have SELECT access?
TEMP_TAG_SEXCODES	List of sex codes, initially populated from OBSERVER.issexcodes.
TEMP_TAG_SPECIESCODES	List of species names, initially populated from OBSERVER.isspeciescodes.
TEMP_TAG_TAGTYPECODES	List of tag type codes and associated information.
TEMP_TAG_TONNAGECLASSCODES	List of tonnage classes. Initially populated from observer.istonnageclasscodes.
TEMP_TAG_VESSELCODES	List of vessels. Initially populated from observer.isvessels. Records are unique by vessel_name, vessel_cfv, reg_year; thus vessel_name and vessel_cfv may repeat with changing license_no by reg_year